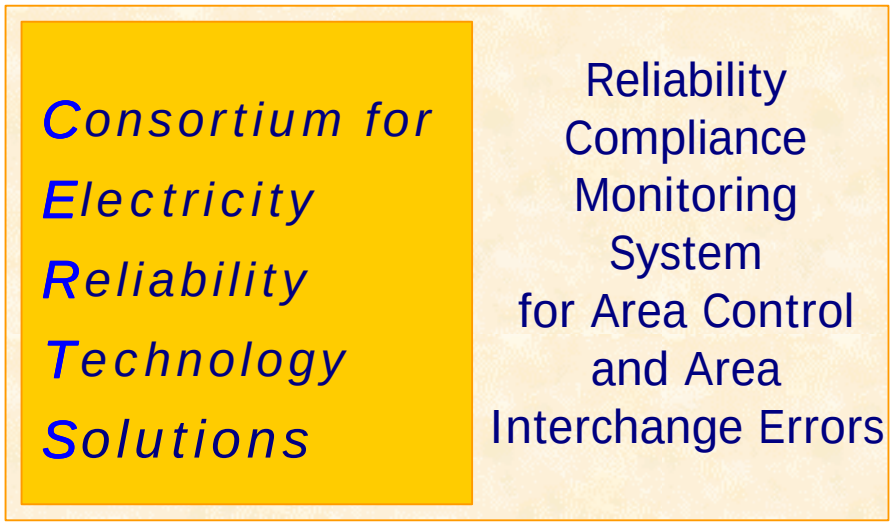

FUNCTIONAL SPECIFICATION
AND DATA REQUIREMENTS FOR

RELIABILITY COMPLIANCE MONITORING SYSTEMS FOR AREA CONTROL AND AREA INTERCHANGE ERROR

FOR THE

NORTH AMERICAN ELECTRIC RELIABILITY COUNCIL (NERC)

(Based on NERC Resources Subcommittee AIE Specification v-1.65)

Version 1.0 - ***CONFIDENTIAL***
Date: March, 2001

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1. INTRODUCTION

1.1 Background

The Consortium for Electric Reliability Technology Solutions (CERTS) has been formed to perform research, develop, and disseminate new methods, tools, and technologies to protect and enhance the reliability of the U.S. electric power system under the emerging competitive electricity market structure. The members of CERTS include former Edison Technology Solutions (ETS), Lawrence Berkeley National Laboratory (LBNL), Oak Ridge National Laboratory (ORNL), the Power Systems Engineering Research Consortium (PSERC), and Sandia National Laboratories (SNL). Southern California Edison (SCE) acts as a CERTS Research Provider.

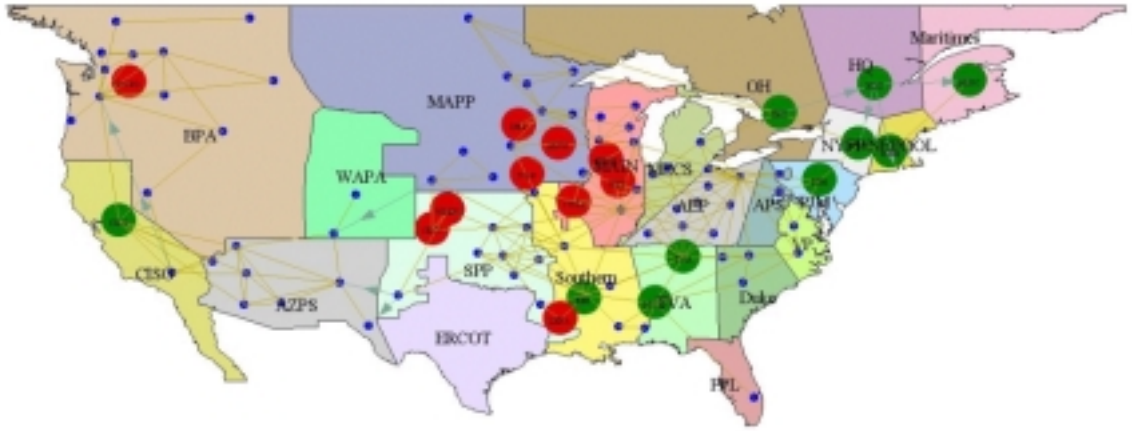
Industry restructuring and FERC's Order 2000 are leading to the formation ISOs and RTOs. The current and developing ISOs and RTOs will manage wide-area transmission grids that are very dynamic and complex. NERC's Security Coordinators will also be challenged to coordinate and support the reliability activities across these wide-area grids. Unfortunately, the existing support systems and tools used to manage the transmission grid are based on the deterministic procedures of traditional energy management system (EMS) data and applications. CERTS, in an effort to address the limitations of the current support applications and tools, developed a vision for wide-area integrated, real time reliability, adequacy and performance monitoring tools.

There is a special need for operational tools that enhances the Security Coordinators and dispatchers ability to quickly assess the adequacy of supply and demand as well as monitor and track the control performance of a balancing authority, within a competitive electricity market. Since 1999, CERTS has been researching, prototyping and demonstrating operational tools to measure, monitor, track and forecast key operational procedures, such as near real-time management of ancillary services, reactive reserve margins monitoring and key performance indices under the uncertainties of market environments. The CERTS existing prototypes mine existing SCADA, analyze it and convert it to meaningful graphical-geographical information for dispatchers and Security Coordinators. In addition, CERTS is in the developmental stage for operational Phasor Measurement Monitoring Systems that use synchronized phasor data from some WSCC transmission owners.

CERTS is funded by Department of Energy to develop reliability applications to support NERC's Security Coordinator functions. The applications to be developed for NERC are the Area Control Error (ACE) and Area Interchange Error (AIE) Monitoring Systems. These applications will be built using the same elements and infrastructure as CERTS is currently using in its other prototype applications. The development and prototyping of the ACE and AIE Monitoring Systems will enhance the Security Coordinators ability to perform compliance monitoring functions with current and future NERC reliability standards for each of the control areas under their jurisdiction. Figure 1 below is the ACE and AIE Monitoring Systems overview map of the NERC Control Areas and their

connectivity. The Security Coordinator, using this hierarchical visualization display, has the ability to drill down into problem areas, during disturbance events.

Figure 1 – North America Reliability Regions, Control Areas and Connectivity



The purpose of this document is to define the functional specification for the ACE and AIE Monitoring Systems. In addition, the document describes the ACE and AIE systems processes required and the graphic-geographic visual components that will allow the Security Coordinators to effectively monitor and analyze wide-area performance and compliance with NERC Standards.

1.2 The Projects Value to NERC

NERC is in the process of developing mandatory compliance standards. An important aspect of a standard is the measurement associated with the standard, so as to determine if the appropriate entities are in compliance. The Security Coordinator will be asked to have a more active role in compliance monitoring. Therefore, they will require the necessary support systems in place to effectively monitor and track current and historical performance, plus the important aspect of looking at the near term behavior. When completed, the ACE and AIE Monitoring System applications will deliver wide-area graphic-geographic performance monitoring capabilities for NERC Security Coordinators.

The ACE and AIE Monitoring Systems, using CERTS' graphic-geographic visualization methodology, will support NERC's Operating Committee and Resources (old performance) Subcommittee's needs for identifying Control Areas that cause large or long-term frequency deviations in each NERC Interconnection. These applications will also allow Security Coordinators to monitor ACE and AIE performance and compliance for each of their jurisdictions using the wide-control-area visualization

1.3 ACE and AIE Monitoring Systems

The ACE and AIE Monitoring Systems to be delivered to NERC will include the following basic components:

- Web base data processing architecture
- Graphic-geographic visualization infrastructure which contain global, local, tracking, and hourly, daily and monthly reliability compliance data.
- Multiple images and plots for ACE, AIE, Frequency and CPS1, and
- Interactive dynamic event replay capabilities.

User will have the ability to choose an assessment of ACE data, AIE data or a combination of both. NERC will provide to the control areas and/or Security Coordinators a secure web site and data capabilities that allow the control areas and/or Security Coordinators to submit the required hourly data. Such input data will be transmitted via the Internet using a XML format. A control area shall be limited to viewing only the data it has submitted and data submitted by its adjacent Control Areas.

The ACE and AIE graphic-geographic visualization displays have the ability to present the results of a performance parameter query in such a way the user can go from a wide-area performance view to the details of specific control area performance data (zoom in and out). The visualizations modules for the assessment of ACE and AIE will be slightly different, so as to meet the users requirements. The applications event replay function allows the user to see ACE or AIE performance in geographic displays for a user-selected geographic area and period of time.

The ACE and AIE Monitoring Systems include an enhanced graphic-geographic visualization subsystem that aids the Security Coordinator in tracking and identifying the real time control performance of its jurisdictional Control Areas. The visualization methods and techniques will assist in mitigating the operational challenges of managing larger and more complex control areas, under competitive market pressures. A key question that the Security Coordinators can now timely answer with the monitoring systems is *"How are the control areas in my security area performing and what is the impact of their control on the system frequency ?***"**

1.4 End Users and the Benefits Derived

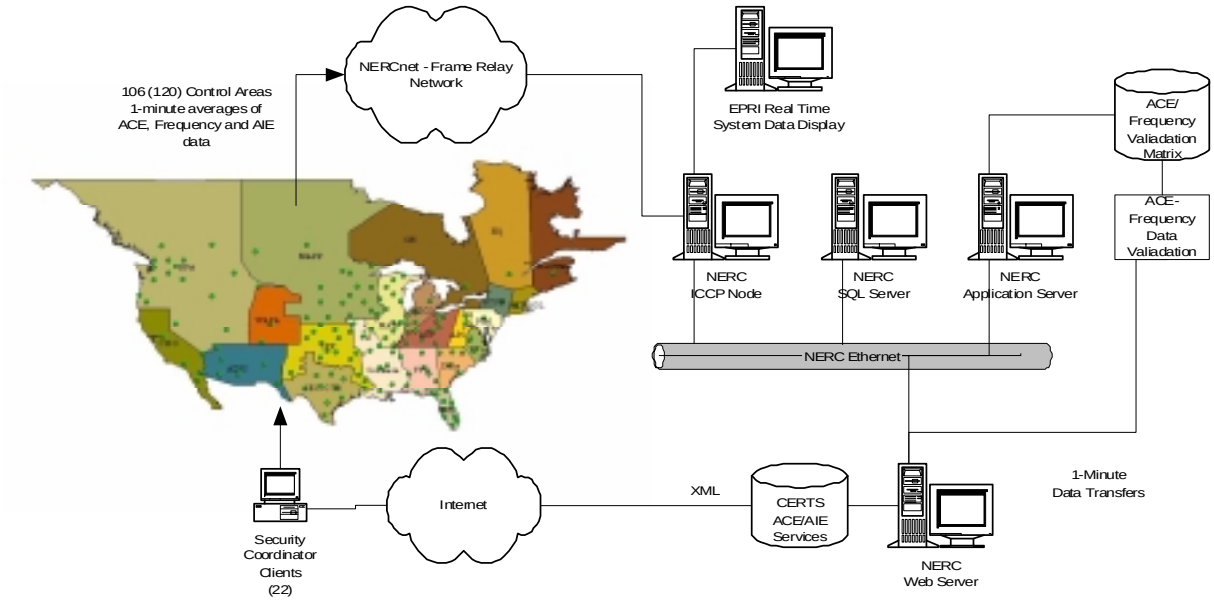
The intended end users of these applications are as follows:

User	Benefits
NERC's Operating Committee and its Subcommittees	The ability to evaluate control areas compliance with ACE and AIE standards, and timely monitor system frequency behavior at different levels: NERC, Interconnection, RTO. Regional Reliability Councils, Security Coordinators, and Control Areas
Security Coordinator	The ability to monitor the ACE and AIE performance for those control areas within their Security Area and ensure reliable operations by actively monitoring any real time non-compliance issues.

1.5 ACE and AIE Monitoring Systems Hardware and Data Communications

The ACE and AIE Monitoring Systems utilizes standard Intel/Windows based workstations interconnected using NERC Local Area Network. This straightforward hardware configuration facilitates integration to NERC's current and future information systems**.** Figure 2, shows the ACE and AIE Monitoring Systems hardware overview. The application architecture uses XML to transfer the data from the client, delivered in conjunction with Microsoft's IIS, ASP and server side business logic.

Figure 2 – ACE and AIE Monitoring Systems Hardware Overview



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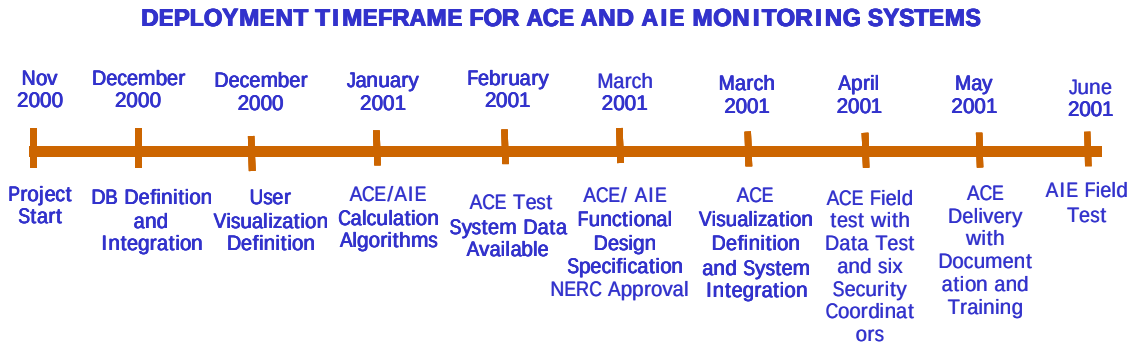
1.6 ACE and AIE Monitoring Systems Deployment Schedule



2. ACE AND AIE COMPLIANCE MONITORING SYSTEM PROCESSESS, SUBPROCESSES AND FUNCTIONAL REQUIREMENTS

2.1 ACE Monitoring Processes and Sub-processes

Figure 3 shows all the processes and sub processes for the complete NERC ACE Monitoring System with the shadow areas indicating the specific processes addressed by CERTS in this specification. The five processes involved in NERC's current system are: a) data validation and correction to minimize incorrect data from entering the NERC ACE Monitoring System, b) bad data reporting, to resolve any problem found with the data, c) run ACE application, to allow the users to monitor the ACE system, d) analysis of data, e) data logging and accounting. The purpose of this section is to describe how the CERTS application will integrate with the existing NERC ACE Monitoring process.

2.1.1 Data Validation and Correction - Figure 3, Process 1

Via NERCnet the control areas submit the data defined in the sections below in a NERC specified format with an hourly periodicity. This data validation and correction processes and sub processes are external to the ACE Monitoring System described in this specification. NERC has established specific procedures to validate and correct the data.

In order to accurately determine control performance problems in balancing generation and load, the accuracy of the reported control performance data must be validated. This is done in a stage process starting at the control area level and continuing with NERC data reasonability validations.

- **Control Area Checkout** – The first level of validation for 1-minute ACE data is done by the individual Control Areas.

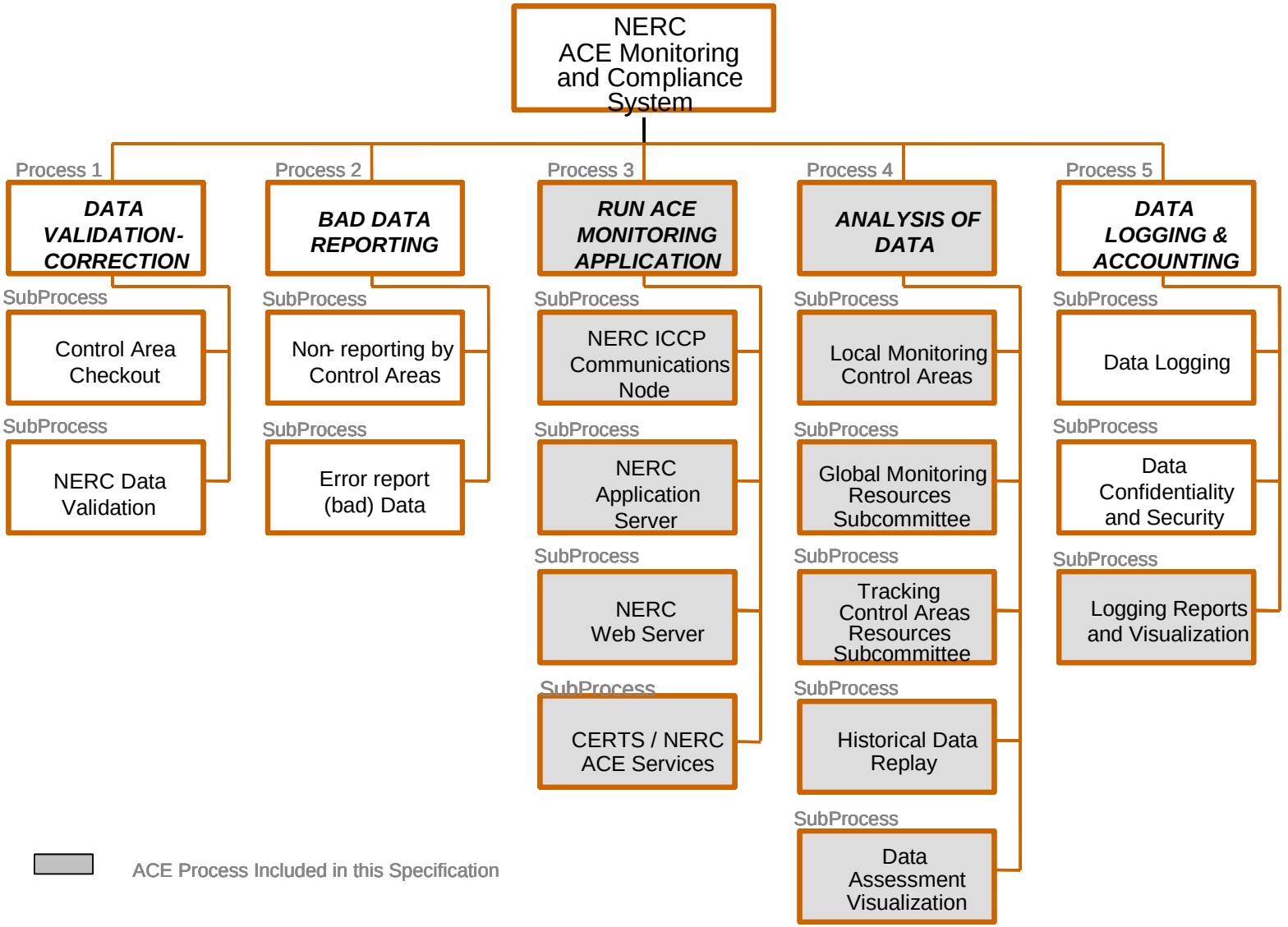
- **NERC Data Validation –** the NERC information technology group using special data validation algorithms does the next level of validation for the 1-minute ACE data.

  Errors uncovered during the validation process must be processed in a timely, coordinated manner. This will prevent interference with the 1-minute ACE process and ensure that poor performers are properly and timely identified.

2.1.2 Bad Data Reporting - Figure 3, Process 2

A number of opportunities exist for data errors to be introduced into the 1-minute ACE process. These errors cannot be allowed to halt the process nor shall they be allowed to initiate false problem indications (either positive or negative). However, bad data reports will be produced to improve the availability and accuracy of future performance data.

Figure 3 – Complete NERC ACE Monitoring Processes



- **Non-reporting by Control Areas** - In general, any Control Area that fails to report shall be required to submit the missing data. Whenever a value is substituted, and when the data is viewed, the system should show the data as substituted

- **Error Report (bad) Data** - Reasonability checks may be used in the future to filter all inputs. Control Areas posting data that does not meet these reasonability checks shall be required to accept data corrections from NERC.

2.1.3 Run ACE Monitoring Application - Figure 3, Process 3

ACE and frequency data delivered by control areas via NERCnet in an hourly basis is routed thorough the following NERC servers:

- **NERC ICCP Communications Node** – This is NERC data communications node in the NERCnet infrastructure.

- **NERC Application Server** – Every hour, automatically, NERC's Oracle database server, after receiving raw ACE and frequency data from the ICCP node, will execute a procedure to archive data in a one month longer circular data file, and pass the most recent data to this application server where most of the performance parameters calculations take place.

- **NERC Web Server** – This web server will respond, via the Internet and XML/ASP architecture to the Security Coordinators clients running an explorer browser.

- **CERTS / NERC ACE Services –** Any other performance calculations or end user responses required for the ACE monitoring system in this specification will take place in this module.

2.1.4 Analysis of Data -- Figure 3, Process 4

- **Local Monitoring Control Areas** – Using the graphic-geographic visualization capabilities and corresponding text information available in the ACE Monitoring System, the user can track the hourly performance of average CPS1 for the selected control area(s) through a 3D map for the last hour, or an hourly image for the last 6 hours. An hourly cave plot is also available to track the average control area(s) ACE vs system frequency deviation both with 1-minute resolution.

- **Global Monitoring Resources Subcommittee** – This functionality allows the resource subcommittee to monitor and track the interconnection(s) frequency behavior through Epsilon-1 (Epsilon-1 is the RMS value of frequency deviation 1-min average). A 3D map for NERC 3 interconnections with the Epsilon-1 and corresponding thresholds are presented to the user. This map is interchangeable with a daily image of Epsilon-1 for the last 24 hours. Also a daily line plot is available for this and last year, showing seasonal periods.

- **Tracking Control Areas Resources Subcommittee** – This function shows the user the CPS1 monthly values, for the selected control areas, in a 3D map or in a multiple image with

daily resolution. A cave plot facing daily frequency deviation and CPS1 is also available in this function.

- **Historical Data Replay** – The user has the capability to replay the behavior of the control area(s) hourly CPS1 or the interconnection(s) Epsilon-1 with hourly periodicity, for any time period selected and enterable by the end user.

- **Data Assessment Visualization –** Combining the different visualization capabilities offered by the ACE monitoring system, the users can start their monitoring and tracking from interconnection overviews, through reliability regions, Security Coordinators jurisdictional areas all the way down to individual control area(s).

2.1.5 Data Logging and Accounting - Figure 3, Process 5

The ACE monitoring application will produce the logging reports defined by NERC and its resource subcommittee.

- **Data Logging** - All data submitted or updated shall be logged. This log shall be available to the Regional Resources Subcommittee representative for dispute resolution. The log shall be time stamped and be capable of being queried to display by Control Area, adjacent Control Area, day, and hour.

- **Data Confidentiality and Security** - All data submitted, updated, or analysis from that data shall not be public information until eight days after the day the data represents (per NERC Policy 4 – Data Confidentiality Agreement). At that time, any party can see any of the views available to the above responsible parties. Before the seven days are passed, only the Control Area, all Security Coordinators, all Resources Subcommittee members (covered by data confidentiality), and NERC staff shall be allowed to view the data.

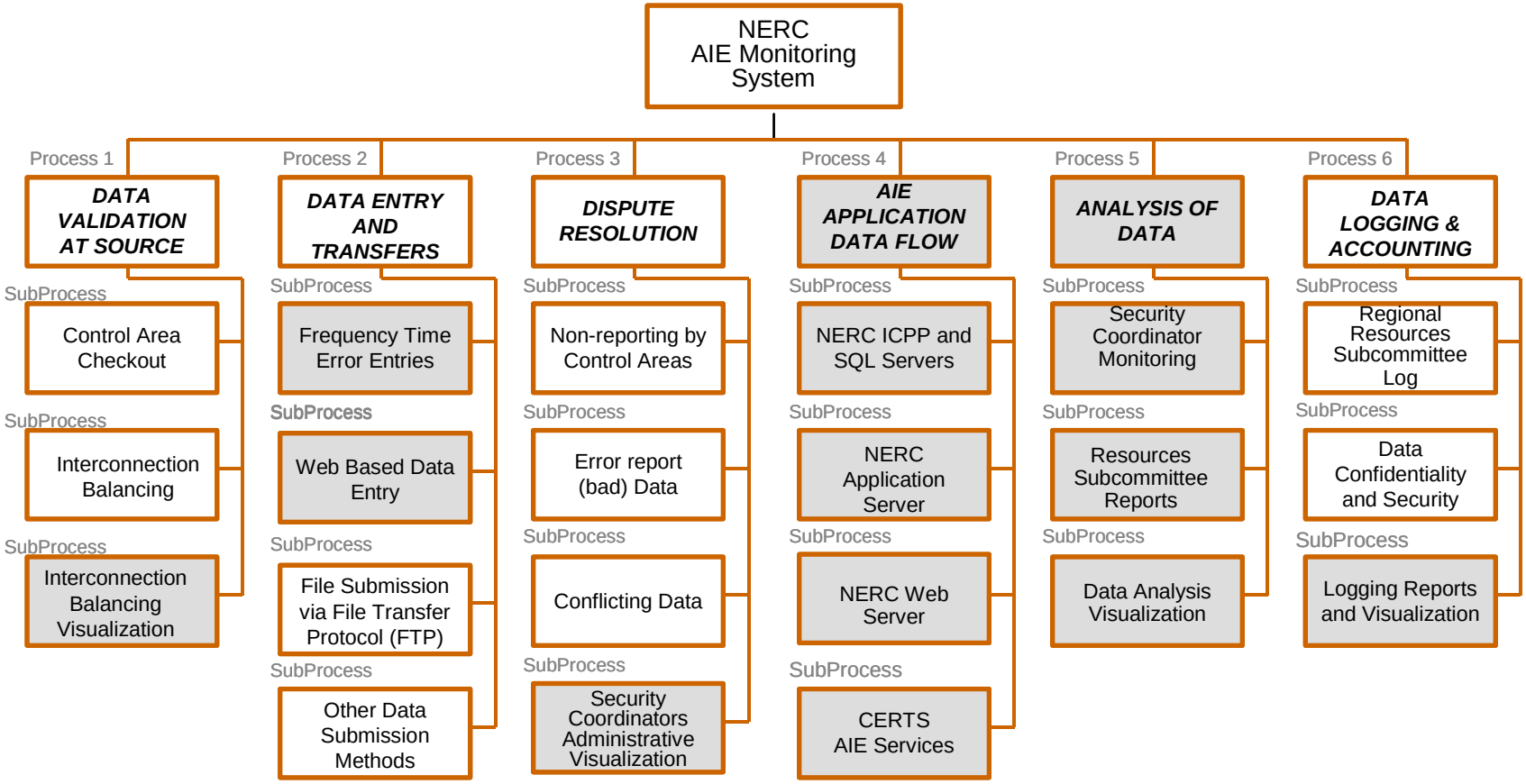
  Only authorized personnel of each Control Area or Security Coordinator shall submit data. To ensure security, a username/password combination will be used until NERC develops a more comprehensive security methodology

- **Logging Reports and Visualization** – Using the ACE Monitoring System visualization capabilities logging reports shall be available.

2.2 AIE Monitoring Processes and Sub-processes

Figure 4 shows all the processes and sub processes for the complete NERC AIE Monitoring System with the shadow areas indicating the specific processes addressed by CERTS in this specification. Six processes are involved in this system: a) data validation at source, in order to identify and correct incorrect data into the system, b) data entry and transfers. The control area is responsible for correcting any errors in order to fulfill their data submission obligations, c) dispute resolution.

Figure 4 – Complete NERC AIE Monitoring Processes



AIE Processes included in this specification

The control area has to resolve any problem found with the data, d) AIE application data flow, to allow the users to monitor the AIE system, e) Analysis of data. This capability allow the user to follow-up the behavior of the AIE system, using the visualization infrastructure of this application, f) Data logging and accounting. Through this process NERC maintains the confidentiality and security of the data. The processes shadows in gray in Figure 4 are addressed in this specification. The purpose of this section is to describe how the CERTS application will integrate with the existing NERC AIE Monitoring process.

2.2.1 Data Validation at Source - Figure 4, Process 1

Control Areas shall submit the data defined in the sections below to NERC or their Security Coordinator in the specified format and timely as required in NERC's specification.

In order to accurately determine where problems exist in balancing generation and load the accuracy of the reported interchange data must be validated. This is done in a two-stage process at the Control Area and interconnection levels. These data validation and correction processes and sub processes are not part of the AIE Monitoring System. Control Areas and NERC have their own internal procedures to validate and correct the data.

- **Control Area Checkout** – The first level of validation for Hourly AIE data is done by the individual Control Areas. NERC Operating Policy 1, Section F, Requirement 4 states:

  Adjacent CONTROL AREAS shall operate to a common NET INTERCHANGE SCHEDULE and ACTUAL NET INTERCHANGE value and shall record these hourly quantities …

  Each CONTROL AREA, by the end of the next business day, shall agree with its adjacent CONTROL AREAS to the hourly-integrated values of … (Net Interchange Schedule and Net Actual Interchange.)

  Thus, by current NERC Operating Policy requirements (passed by the NERC Board of Directors 2/7/00), each Control Area should have checked out with adjacent Control Areas and validated the data required for Hourly AIE no later than the end of the next business day. Unfortunately, not all Control Areas can meet these requirements at this time. Thus some implementation period will be required before data validated at the Control Area level will be available for Hourly AIE purposes on a daily basis.

- **Interconnection Balancing –** The next level of validation for Hourly AIE data is done by the NERC Resources Subcommittee Representative utilizing the system provided by NERC. This validation consists of compiling the results from each of the Control Area Hourly AIE reports and comparing the Hourly Net Actual Interchange and Hourly Net Scheduled Interchange reported by adjacent Control Areas.

  Errors uncovered during the validation process must be processed in a timely, coordinated manner. This will prevent interference with the Hourly AIE process and ensure that poor performers are properly identified without falsely identifying those Control Areas providing their proportional share of support to the interconnection. Standards must be set and

procedures set forth to measure the performance of the Hourly AIE process and identify poor reporting performance as well as poor regulating performance.

Control Areas shall resolve disputes with bilaterally submitted data within the timeframe required in NERC Operating Policy 1F. Control Areas shall update the data when disputes are resolved as required in this specification.

- **Interconnection Balancing Visualization –** The NERC Resources Subcommittee Representative, utilizing the AIE Monitoring System provided by CERTS, does this level of data validation. The validation consists of monitoring the results from each of the Control Area Hourly AIE reports and comparing the Hourly Net Actual Interchange and Hourly Net Scheduled Interchange reported by adjacent Control Areas.

2.2.2 Data Entry and Transfers - Figure 4, Process 2

Control Areas shall submit any corrections to previously submitted data by one of the methods of collection shown below by their close of business the next business day immediately following the resolution of any disputes. These data correction processes and sub processes are not part of the AIE Monitoring System being specified here.

- **Frequency Time Error Entries –** The data entry submission begins with the frequency time error data. The Control Areas have the responsibility to send to NERC, hourly, the frequency time error.

- **Web Based Data Entry –** The AIE Monitoring System shall provide to the Control Areas and/or Security Coordinators a secure web site and data entry form that allows the Control Areas and/or Security Coordinators to submit the required hourly data. The Control Area shall be limited to viewing only the data it has submitted and data submitted by its adjacent Control Areas that correspond to its data. This web-based data entry shall also be available for updating any hour of any data of submitted data. The data entry shall also show the value as submitted by the adjacent Control Area. The data entry shall highlight any disputes between values per hour in such a way that the Control Area is clear about disputes with other adjacent Control Area. The data entry/updating shall accept any revisions to data submitted but shall not change the original submitted data until the revisions between adjacent Control Areas agree.

  The above capabilities should be provided via the administrative views described in section 3.2.1 of this specification.

- **FTP File Submission** – NERC shall provide to the Control Areas a secure FTP site that accepts data in a required XML format (The submission will not be overridden by subsequent submissions). This format is documented in Appendix A. NERC shall validate the data and any errors/concerns found in the submission shall be provided to the Control Area on the FTP site or e-mailed to a registered e-mail address for each Control Area. These errors/concerns shall also reflect any values that were submitted that are in dispute. The Control Area is responsible for correcting any errors in order to fulfill their data submission obligations. The FTP site shall limit the Control Area to only see the data it has submitted

and any reply error files that the system returns for that Control Area. The same XML format shall be used to update the data in total or in parts.

Each Security Coordinator that submits data shall also have the capability to combine Control Area data into one submission or submit by individual Control Area. The Security Coordinator shall return any reply error files that the system returns for a Control Area to the Control Area.

- **Other Data Submission Methods** - The Resources Subcommittee shall review any other method proposed for data submission. If the Resources Subcommittee deems this to be a superior or equivalent data submission method, it can approve it for use either by the party proposing it and also may change the data submission methods. One suggestion is to use HTTP, as it gives immediate responses back upon submission.

2.2.3 Dispute Resolution - Figure 4, Process 3

A number of opportunities exist for data errors to be introduced into the Hourly AIE process. These errors cannot be allowed to halt the process nor shall they be allowed to initiate false problem indications (either positive or negative). A general philosophy for error handling shall be developed early in the project and elaborated as needed for the various detailed design areas. These dispute resolution processes and sub processes are NERC responsibility and are not part of the AIE Monitoring System.

- **Non-reporting by Control Areas** - In general, any Control Area that fails to report shall be required to accept the data from the adjacent Control Areas that do report. Whenever a value is substituted, and when the data is viewed, the system should show the data as substituted.

- **Error Report (bad) Data -** Reasonability checks based on published OASIS or transmission planning study data may be used in the future to filter all inputs. Control Areas posting data that does not meet these reasonability checks shall be required to accept the data from the adjacent Control Areas, which report reasonable data or to communicate the reason(s) why the data is outside normal boundaries**.**

- **Conflicting Data** - Adjacent Control Areas which report conflicting data (data which does not agree) shall be required to accept the value which provide the largest inadvertent for each Control Area until the disagreement can be resolved.

  NERC Operating Policy 1F requires disputes be resolved and names several parties that are involved in the dispute resolution process. Particularly this involves the Control Areas in dispute, the Regional Resources Subcommittee Representative, the Region's Dispute Resolution and NERC Operating Policy Appendix 1F Dispute Resolution Process. As such, NERC shall provide to each of these parties views of the data to assist in highlighting and recording dispute resolution. The views for the Control Areas in dispute have already been addressed above.

  The application shall also provide the views described in section 3.3.1 to the Resources Subcommittee.

Additionally, NERC shall provide to the Resources Subcommittee weekly reports highlighting disputes outstanding for more than a month, including their age, status, and changes not accepted because of a continued disagreement.

- **Security Coordinator Administrative Visualization –** Security Coordinator utilizing the AIE Monitoring System provided by CERTS does this level of data correction. Data errors can be found using the visualization capabilities at Control Area level and comparing data with adjacent Control Areas.

2.2.4 AIE Application Data Flow - Figure 4, Process 4

Running the AIE application shall allow the Security Coordinators and NERC resources subcommittee representatives to monitor the Area Interchange Errors at different levels: NERC interconnections, RTOs, reliability regions, Security Coordinators and control areas.

In order to support all this data flow, NERC, through Ethernet connection, has an ICCP node, a SQL Server, an Application Server and a Web Server. Figure 2 shows the complete hardware configuration. The functionality for each server follows.

- **NERC ICCP Node** – NERC ICCP Communication Node within the NERCNet.

- **NERC SQL Server** – Hourly, AIE data submitted by each Control Area, and validated according processes explained before, shall be incorporated to the NERC SQL Server. Through this specific process the new data will be part of the regular AIE data and will be used to do the appropriate calculations needed for performance monitoring and compliance purposes.

- **NERC Application Server** – Every hour, automatically, the AIE Monitoring System will execute a procedure to calculate AIE average to be used with hourly, daily and monthly monitoring displays.

- **NERC Web Server** – Hourly, automatically, NERC will execute a procedure to archive data for one month.

- **CERTS AIE Services** – Using the AIE Monitoring System visualization capabilities NERC representatives and Security Coordinators shall have access to AIE data through geographic and graphic displays that allow them to monitor the behavior of the power control system and to easily identify abnormal frequency deviations and its origin.

2.2.5 Analysis of Data - Figure 4, Process 5

In the future, NERC may use the data for Inadvertent (on-peak, off-peak, and total) accounting and balancing for Control Areas that submit the data. If a Control Area is not submitting the data as required, the Control Area would be required to submit a written plan defining when their data will be submitted.

- **Security Coordinator Monitoring** - The AIE Monitoring System shall provide to the

Security Coordinators geographic and graphic views to facilitate the analysis of the data and also views of submitted data.

The above capabilities shall be provided to the Security Coordinators via the views described in section 3.3.2.

- **Resources Subcommittee Reports** – The analyses executed include Frequency errors, CPS and DCS validation

  - Frequency Meter Error - NERC shall provide to the Resources Subcommittee a report monthly that identifies any Control Area that has a significantly different average frequency for any hour than the NERC reference frequency.

  - CPS Validation - NERC shall provide to the Resources Subcommittee a monthly report that analyzes the difference between the CPS reported data and the AIE reported data.

  - DCS Validation - With the views provided to the Regional Resources Subcommittee Representative, DCS can be validated.

2.2.6 Data Logging and Accounting - Figure 4, Process 6

These logging and accounting processes and sub processes are NERC responsibility and are not part of the AIE Monitoring System with the exception of the logging report.

- **Regional Resources Subcommittee Log** - All data submitted or updated shall be logged. This log shall be available to the Regional Resources Subcommittee Representative for dispute resolution. The log shall be time stamped and be capable of being queried to display by Control Area, adjacent Control Area, day, and hour, and return all data entries for that time period as well as the comments noted by the Representative.

- **Data Confidentiality and Security** - All data submitted, updated, or analysis from that data shall not be public information until eight days after the day the data represents (per NERC Policy 4 – Data Confidentiality Agreement). At that time, any party can see any of the views available to the above responsible parties. Before the seven days are passed, only the Control Area, all Security Coordinators, all Resources Subcommittee members (covered by data confidentiality), and NERC staff shall be allowed to view the data.

  Only authorized personnel of each Control Area or Security Coordinator shall submit data. To ensure security, a username/password combination will be used until NERC develops a more comprehensive security methodology.

- **Logging Reports and Visualization** – Using AIE Monitoring System visualization capabilities logging reports shall be available.

3. NERC FUNCTIONAL AND VISUALIZATION REQUIREMENTS FOR THE ACE AND AIE MONITORING SYSTEMS

3.1 NERC Visualization Requirements for ACE Monitoring System

- A menu view to select a region, then a control area and display its average ACE 10-minute values, hourly or daily.

- A menu view that shows CPS1 for all or selected control areas, on a monthly basis, allowing the Security Coordinator the control's area submitted data (ACE 1-minute resolution data).

- A menu view to select a particular day/hour for viewing. From this display, the Security Coordinator can view the CPS1 for a selected control area for a specific day or hour. This resultant control area level detail view shall also show the 1-minute average of the ACE data collection for the same hour and the frequency 1-minute resolution data.

- A menu to view the previous menu (above) for yesterday and 7 additional days into the past.

- All the views available to the Regional Resources Subcommittee Representative.

3.2 NERC Visualization Requirements for AIE Input Data

The control area submits the input data using a Web based data entry in XML Format. Appendix C contains a copy of the XML Format.

3.2.1 NERC Visualization Requirements for AIE Administrative Views

NERC will provide the following administrative views for the control area input data:

- A view of the daily totals for net actual interchange, net scheduled interchange, inadvertent, and AIE.

- A menu with the ability to select a specific date and time to allow quick access to a potential non-compliance hour.

- A menu of the days that data is missing. This should reflect any days that the Control Area has failed to submit data and the number of days that the Control Area is in non-compliance.

- A menu of the days that data is incomplete. This should reflect any days that an adjacent Control Areas has failed to submit data.

- Time Error Corrections as entered by the Interconnection Time Error Monitor.

3.3 NERC Visualization Requirements for AIE

The AIE processes and sub processes related to resolve data problems are NERC responsibility and those processes are not part of the AIE Monitoring System.

3.3.1 Conflicting Data - NERC requires the following views for the Regional Resources Subcommittee Representative:

- Menu view to show, by month, each Control Area that has failed to submit data and the number of hours in non-compliance.

- Menu view to show each dispute within the region. This should include disputes between regions. The menu should allow the NERC Representative to go to the disputed days and hours. This view shall also show any values that have been entered by the control areas but have not changed the original submission data because they still have no agreement. The Regional Representative should be able to record comments with each disputed value.

- Menu view to show changes not accepted because of a continued disagreement. There are cases where the data as originally submitted was in agreement, but one party has a subsequent dispute and has entered a new value that is not accepted because the Adjacent Control Area's data is not in agreement. This menu view should allow the NERC Representative the same capability as above.

- Time Error Corrections as entered by the Interconnection Time Error Monitor.

- Additionally, NERC shall provide to the Resources Subcommittee weekly reports highlighting disputes outstanding for more than a month, including their age, status, and changes not accepted because of a continued disagreement.

3.3.2 Analysis of the Data

- A menu view to select a region, then a control area that shows their AIE by hour or day.

- A menu view to show all control areas, current month, with an hourly AIE greater than 100% (configurable) of their L_{10} and the ability to select any of these control areas to show the days and hours of theses AIE values. The Security Coordinator will then be able to look at the control's area submitted data. This resultant view shall also show the ten-minute average of the ACE data collection for the same hour.

- A menu view to select a particular day/hour for viewing. From this, the Security Coordinator should be able to view the control areas with AIE greater than 100% (configurable) of their L_{10} for that hour. A summary of those control areas shall also be on that view with the ability to examine a single control area for the hour from the summary. This resultant control area level detail view shall also show the ten-minute average of the ACE data collection for the same hour.

- A menu to view in 3.3.2.3 (above) for yesterday and 7 additional days into the past.

- All the views available to the Regional Resources Subcommittee Representative.

4. ACE AND AIE MONITORING SYSTEMS VISUALIZATION OVERVIEW

4.1 ACE and AIE Hierarchical Visual Assessment And Analysis

The design criteria for the layout of the user visualization follows an equivalent approach to the one used for SCADA and EMS displays for real time operators. It has been demonstrated by dispatchers that the more effective operational displays are those that follow a hierarchical approach to present operational data. In this hierarchical approach, very critical data is presented at the high level on a very simple system display. From the high-level system display the dispatchers can drill down to lower level detail displays in the hierarchy with minimum or none menus and a minimum intuitive set of keystrokes.

The ACE and AIE monitoring systems shall provide the Security Coordinators with graphical and geographical displays to determine, in a timely manner, which control area or set of control areas are responsible for deviations from balancing their generation, load and interchange on a minute basis for ACE and in an hourly basis for AIE.

The ACE and AIE graphic-geographic visual analysis layers have been designed to facilitate the interpretation of the results from each of the above functions. Taking advantage of the visualization technology available, it presents past and current information for each Security Coordinator on, 2D and 3D graphical-geographic and concurrent visualization displays at different levels: NERC interconnections, RTOs, reliability regions, Security Coordinators and control areas.

The AIE functional definition follows the requirements from the NERC resources subcommittee specification. CERTS is addressing the requirements with its own graphic-geographic visualization layer, in such a way that the Security Coordinators can follow a very simple sequence of displays to track the performance of each control area with respect to ACE frequency and balancing load, generation and interchange.

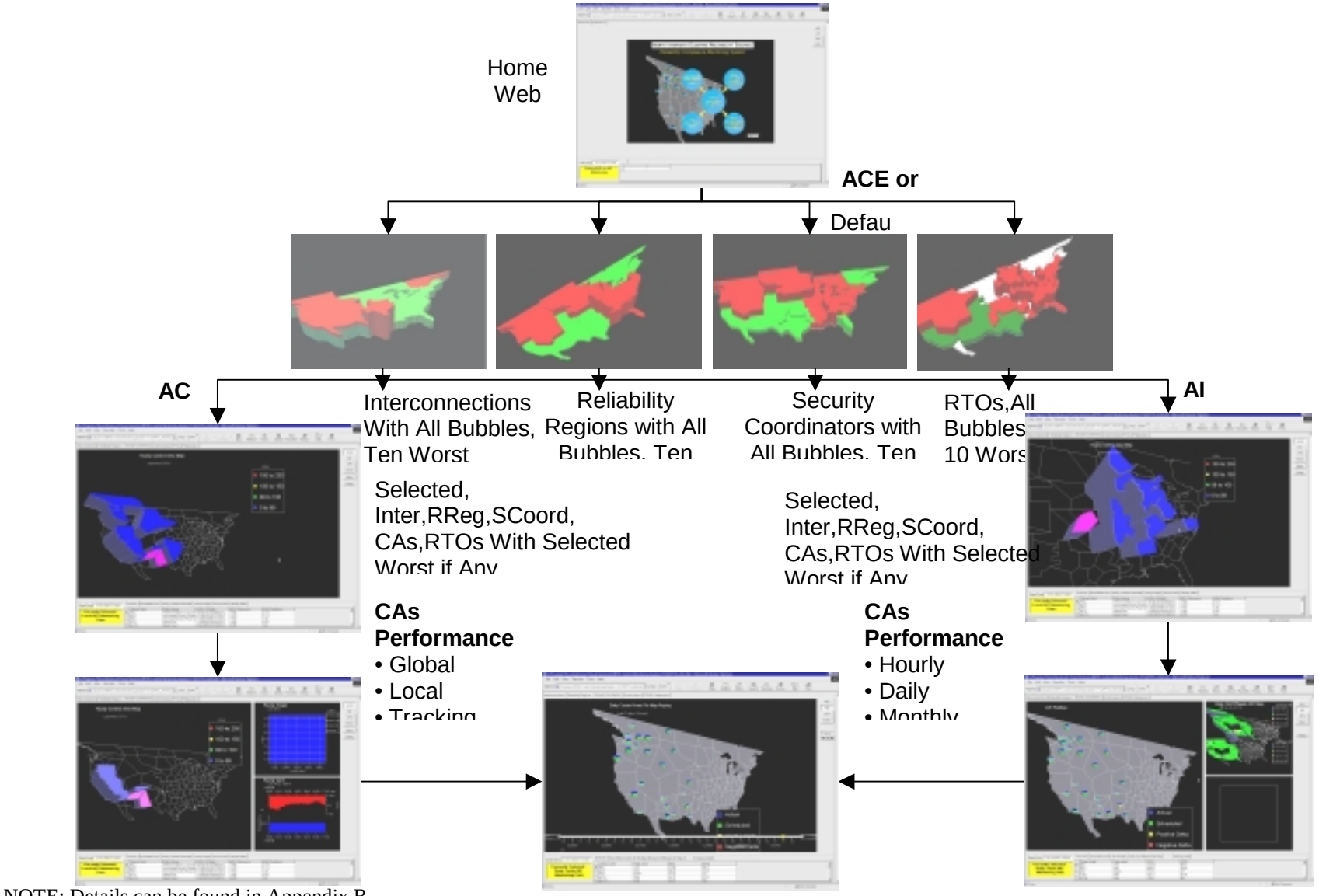
Figure 5 is the ACE and AIE Visualization Overview. Using A Web Browser the authorized user open the NERC Reliability Compliance Monitoring System Web Home-display. The figure shows the sequence followed by the user to monitor ACE and AIE.

- The first display is the Home Web Page that, through the ACE and AIE poke points, allows the user to select either of the two systems ACE or AIE monitoring.

Once users select either ACE or AIE they will get the Interconnections display with four additional tabs on top to select specific boundaries for reliability regions, security coordinators and RTOs.

- Interconnections (default option) to monitor the performance of the interconnection via its epsilon parameter and showing the ten control areas with the ten worst ACE or AIE values.
- Reliability Regions, to monitor ACE or AIE performance for the selected region or regions

Figure 5 – ACE and AIE Visualization and Navigation Overview



NOTE: Details can be found in Appendix B

- Security Coordinators, to monitor ACE or AIE performance in the selected Security Coordinators.
- RTOs, to monitor a specific RTO area or RTO areas.

From either of the above selected boundaries, users can select the level they are interested to analyze and assess and, from that point on, all displays will show only the selected boundaries keeping the visualization criteria of offering to users an infrastructure for going from generic to more detailed and specific data. Additionally, the user can choose the timeframe according to the options offered by the program and the resolution of the specific data. Each one of these options allow the user to go from a general overview to a deeply view of the data. The geographic and graphic hierarchy displays facilitate the analysis and assessment of the data through a sequence of 3D or 2D maps, images and cave or line plots.

The following displays allow for that:

- ACE option shall show the boundaries with the ACE/L_{10} ratio for the selected control areas.
- AIE option shall show the boundaries with the AIE/L_{10} ratio for the selected control areas.
- For both, ACE or AIE, the user should be able to see the map showing the selected Control Area performance with ten worst and best control areas highlighted, if any.
- From the main ACE visualization, a right-mouse button click generates a list where the user can select Global, Local or Tracking displays. When selecting the Local or Tracking option, the user will go to a 3-panel display going from generic data via 3D to very detailed data via image and cave displays. Then, the user shall be able to select all the data related to that level or data related to adjacent 1, or adjacent 2 and Time. The timeframes are hourly, daily and monthly (See Table B1 in Appendix B).
- For AIE the user can select the options to see the Performance Monitoring, Historical Monitoring or Data Entry. The timeframes for the first two options are hourly, daily and monthly (See Table B2 in Appendix B). The AIE visualization offers a master display with three main panels to simultaneously observe different but related performance parameters for different but related periods of time via 3D maps.

The user will have the ability to switch between displays, which show all three visualization areas and single specific visualization area, using single key presses. In the maps, 2 concentric circles represent control areas. Moving the mouse over a circle will display the control area name. On the page, in the upper right, there are buttons that can be used to zoom the display. The *zoom in* button has a picture of a magnifying glass with a plus sign, and the *zoom out* button has a picture of a magnifying glass with a minus sign. There are 5 levels of zoom.

- Interactive replay for selected control areas for ACE or AIE performance is also available to the user from any panel. The replay display allows a user selection or an automatic selection. User selection means the user has the opportunity to choose the point to begin the replay in the time frame specifically offered by the program. Automatic replay shall run for the complete timeframe offered; however the user can stop the replay in any time.

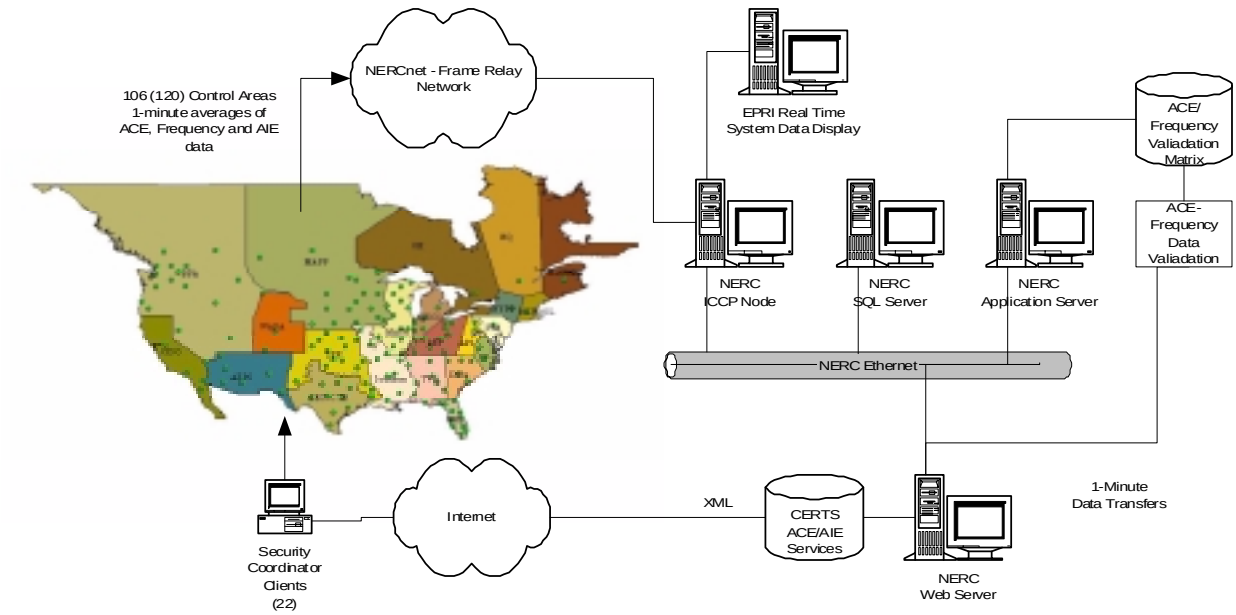
Detail description of the visualization concept, integration and some other exploratory visualization can be found in Appendix B.

5. ACE AND AIE SYSTEMS HARDWARE, DATA COMMUNICATIONS AND VISUALIZATION ARCHITECTURES

5.1 ACE and AIE Systems Architecture and Data Communications

Figure 6 shows Systems Architecture and Data Communications for ACE and AIE Monitoring Systems. The applications architecture uses XML format to transfer the data from and to the client, delivered in conjunction with Microsoft's IIS, ASP and server side business logic. The clients, through Internet, submit the ACE and AIE data. These data are stored in NERC server database and automatically NERC execute the procedures to validate and correct the data. The users, also through Internet, shall be able to monitor the ACE and AIE behavior using the applications developed by CERTS and their visualization capabilities already described in this specification.

Figure 6 – ACE and AIE Systems Architecture and Data Communications



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6. SECURITY REQUIREMENTS

6.1 User Access

User access shall be password protected based on registered user IDs and passwords.

ACE and AIE Monitoring Systems shall be accessible by NERC, Security Coordinators and all control areas.

Users shall be designated as signatories of the NERC ISN confidentiality agreement or non-signatories. Signatories of the NERC ISN confidentiality agreement shall have unrestricted access to all user information and displays.

Access by non-signatories of the NERC ISN confidentiality agreement shall be restricted such that the user may view detailed information. Certain application options will not be available to all users except signatories of the NERC ISN confidentiality agreement and entities that are specifically authorized by NERC.

7. PERFORMANCE REQUIREMENTS

The end-to-end processing time for any allowed query or study request shall be limited to 10 seconds. End-to-end processing time starts with receipt of the query by the application and ends with the transmission of the results by the application Internet Service Provider. Internet transmission and user processing times are not included in the 10-second requirement.

At least 30 concurrent users shall be supported.

8. PLATFORM SUPPORT, DEPLOYMENT AND DELIVERED PRODUCT

8.1 Platform Support

- The software shall be designed for the Windows 98/NT Intel PC platforms.

- The software shall be designed using the latest version of Openviz(v1.4)

- The software will be delivered as an Active X control designed to run within Internet Explorer v5.0 (or higher) and Netscape. Delivery for Netscape will be achieved through the use of a third party ‘plug-in’ such as Esker PLUS 3.0 by Esker (not provided with the application). Due to time and data constraints of this project, the functionality will be validated for Netscape, but will not be fully tested or supported.

8.2 Deployment

- Intermediate deployment (i.e. deployment to NERC during development) will consist of the

application running on the client within a web browser. Data will be loaded from a Microsoft Access database and ESRI Shapefiles (as discussed above) residing on the client machine.

- Final deployment will consist of the application running on the NERC infrastructure within a web browser (Internet Explorer v5.0 or Netscape). Data will be loaded from an Oracle database residing on a web server, accessed using Microsoft's ActiveX Data Objects.

8.3 Delivered Product

The product to be delivered by CERTS will consist of the application (executable code), and any appropriate data and any additional software developed by CERTS specifically for the NERC ACE AND AIE project.

9. ACE TRIAL PROCESS

There will be three major objectives during the fifteen days duration of the trial process:

- Test the integrated systems including both NERC servers and Security Coordinator clients

- Test system performance and stability, verifying the web-visualization response for clients located in different geographical locations.

- Get five to six Security Coordinators feedback about Relaibility Compliance Monitoring System functionality, visualization and performance.

NERC Relaibility Compliance Monitoring System (CMS) software will be installed and individually tested in the NERC Web Server. Six trial client software installations will be prepared and delivered to the six Security Coordinators trial-hosts. A preliminary User's Guide and functional brochure will be available as part of the trial installation process to help the Security Coordinators to utilize the system.

Tailored response forms will be created and delivered to the trial Security Coordinators to get their feedback during the fifteen days of the trial process. A support person will be available on the phone during the trial period to respond to major system problems and / or major utilization questions.

Once trial Security Coordinators feedback is collected, integrated and assessed, CERTS / NERC will define what changes will be considered for implementation before final system delivery.

A similar trial process will be defined and executed for the AIE Monitoring System.